Work Plan for Webster-Gulf Nuclear Site

Site:
Webster-Gulf Nuclear Facility
202 W. Medial Center Boulevard
Webster, Texas 77598

Prepared for:
U.S. Environmental Protection Agency
Region 6
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July 29, 2003

Earth Tech Project No. 53756.04

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1.0 INTRODUCTION

This work plan provides a functional guideline for the excavation of contaminated soils associated with portions of the Gulf Nuclear facility in Webster, Texas. Minor variations in scope and approach may be required as the project is implemented. Major variations in the scope of work, materials, quantities, or schedule that may be caused by unforeseeable field conditions will be addressed as modification or amendments to the original work plan. If properly executed, this work plan will accomplish the fulfillment of this future task order and removal of the Webster-Gulf Nuclear contamination. This plan will provide the methodology, means, and direction for the preplanning, mobilization and long-term response for this project, in a cost effective, efficient and safe manner.

2.0 SITUATION

The Gulf Nuclear facility established in Webster, Texas in 1971 came "under ownership and control of Gulf Nuclear of Louisiana, Inc A Subsidiary of the GNI Group, Inc. in 1992."(CRCPD.org Annual Meeting 2003). Gulf Nuclear manufactured devices containing radioactive material containing americium-241 (^{241}Am), cesium-137 (^{137}Cs), iridium-192 (^{192}Ir), radium-226 (^{226}Ra) (and its progeny), and gadolinium-153 (^{153}Gd), during the period of 1971 and 1987. Gulf Nuclear made devices that were used in a variety of applications such as radioactive tracers for the oil industry, medical diagnostic devices, industrial radiography, oil and gas well logging, and fluid-density gauges. Production of sealed sources ceased in 1987.

> "In 2001, in light of the failure of GNI to conduct its own cleanup… Texas Department of Health (TDH) called upon the Texas Commission on Environmental Quality (TCDEQ) and the federal Environmental Protection Agency (USEPA) for assistance"(CRCPR.org Annual Meeting 2003). During USEPA's involvement with the clean up of the facility over 260 radioactive sources and widespread radiological contamination has been found" (Region 6 Pollution Report May 22, 2002).

The USEPA cleanup team described housekeeping at the Webster-Gulf Nuclear facility as extremely poor. The Federal cleanup team expected to find most of the radioactive contamination confined to hot cells and glove boxes, where the radioactive materials were stored and used to make sealed sources, but found protective containers of radioactive material left open. The building's ventilation system was highly contaminated. Americium contamination was widespread. About $10,000 worth of radioactive americium powder was found lying in an open box. Glove boxes were coated with radioactive powder. Raw materials were found spilled on the floor. Workers apparently used plastic coffee cups to mix radioactive chemicals that they then stored in plastic ice trays. Investigators found a room sealed off from the rest of the building that contained thousands of dollars worth of highly contaminated equipment.

2.1 CERCLA Preplanning, Tasking 4

Earth Tech received tasking 4 under Task Order 1 under USEPA Contract 68-S6-02-02 on 6/6/2003. The delivery order outlined the following tasks:

- Prepare detailed cost estimate for excavation of the contaminated soils.
- Prepare work plan for excavation of contaminated soils.
- Prepare cost estimate and work plan for removal of debris.
- Prepare cost estimate and disposal arrangements for all site wastes.
- Prepare cost estimate for after-hours site security.
- Prepare detailed plans to prevent cross contamination.

2.2 Understandings

Our understanding is that all sealed sources have been removed from the site. Possible radioactive contamination in the soil at the Webster site includes the isotopes, americium-241 (^{241}Am), cesium-137 (^{137}Cs), iridium-192 (^{192}Ir), radium-226 (^{226}Ra) (and its progeny), and gadolinium-153 (^{153}Gd). Gulf Nuclear also manufactured products containing other isotopes with short half-lives that need not be considered for the purposes of this project. We understand that the soil contamination is confined to the top 30 cm of soil, but there are areas with contamination at 30-45 cm below grade. The area of contamination is 95 feet × 300 feet (29 meters × 91 meters). The contamination is not uniform throughout the site.

Results of a characterization survey will be available before this project begins. This site characterization survey will be used to refine and adjust this work plan when it becomes available. However, EPA officials indicated to Earth Tech that the exposure rate at an area near the center of the site is about 500 micro roentgens per hour ($\mu R\ h^{-1}$). Otherwise, exposure rates at most locations at the site are near background levels (approximately 6 $\mu R\ h^{-1}$ to 8 $\mu R\ h^{-1}$).

3.0 TECHNICAL APPROACH

Earth Tech developed this work plan at the request of the On-Scene Coordinator (OSC) and Project Officer to outline cost, schedule, logistics, manpower, equipment and procedures to accomplish this response in a safe and efficient manner. Special consideration will be given to proven radiological work practices that will reduce worker exposures, provide segregation of materials by radioisotope and concentration, and severely reduce cross contamination. Earth Tech's goals for this remediation is to protect the workers, public and the environment; accomplish waste minimization and segregation; provide free release of the site for unrestricted use; complete free release of all equipment; control all releases of contaminants and prevent cross-contamination. Survey design will be in accordance with guidelines in the *Multi-Agency Radiation Survey and Site Investigation Manual* (abbreviated in this work plan as MARSSIM), rev. 1, August 2000 (NUREG-1575, EPA 402-R-97-016, and DOE/EH-0624). Cleanup standards will be determined based on 25 Texas Administrative Code (TAC) 289.

Our approach will be divided into preplanning, mobilization, long term response and close out. Preplanning will involve a full transportation and disposal plan, site-specific health and safety plan (HASP), procurements, and training. Mobilization will involve mobilization of crew and equipment, collection of initial bioassays, assignment of personal detectors (TLDs), delineation of the work zones, establishment of radiologically controlled areas, review of safety plan and decontamination techniques. The long-term response will be the body of the technical approach including methods for removal of contaminated soils and debris, loading trucks, segregation and minimization of contamination and prevention of cross contamination. Close out will include subcontract close out, site break down, free release of equipment, free release of the site, state notifications, and site restoration.

3.1 Preplanning

Preplanning will involve the completion of the transportation and disposal plan, site-specific health and safety plan (HASP), procurements, quality assurance protection plan (QAPP) and training. We will also complete logistics for crew mobilizations, trailer setup, and utilities.

Earth Tech will develop a full transportation and disposal plan prior to mobilization. An OSC/Contracting Officer (CO) consent package will be included for completion of the transportation procurement for delivery of the radioactive contaminated soil to Envirocare of Utah. The consent package will include competitive pricing for rail and road transportation of the radioactive waste, a contract with the winning vendor, and our justification for the award. The transportation and disposal plan will include completed waste profiles for radioactive and nonhazardous waste streams. The plan will include documentation for competitive bids for radioactive disposal, radioactive waste transportation, nonhazardous landfill disposal, and nonhazardous landfill transportation. A soil-sampling event and disposal analytical may be needed for each waste stream profile.

Earth Tech's Health and Safety Department in Grand Rapids, Michigan will develop a comprehensive site-specific HASP with aid from our radiological department in San Antonio, Texas. This plan will address the physical hazard associated with the site including debris, traffic, excavations, and heat stress. The HASP will discuss the chemical hazards associated with the sites such as beryllium. A detailed section completed by the Certified Health Physicist (CHP) or Radiation Safety Officer (RSO) will address the hazards from radioactive elements, primarily cesium and americium but will also include sections on iridium, radium, gadolinium, and uranium. Detailed procedures will be outlined for handling the radioactive contaminated materials at the Gulf Nuclear Site and the decontamination of workers, equipment and trucks.

A purchasing agent will be assigned to the project accompanying the Response Manager (RM) and Field Cost Accountant (FCA), and Transportation and Disposal (T&D) Coordinator. They will be directly involved with the procurement of the necessary supplies, equipment, and subcontractors. The purchasing agent and T&D coordinator will complete the transportation subcontract and disposal subcontract for the radioactive and nonhazardous waste streams. The purchasing agent and RM will complete a contract for after hours site security. The RM, FCA and purchasing agent will competitively bid heavy equipment pieces required at this site. The anticipated main heavy equipment pieces will be a mini-excavator,

excavator, large forklift, and rental cars. Procurements will also be completed for site trailers, PPE, and office supplies.

The RSO will work with the FCA and purchasing agent for procurement of the radioactive detection equipment and supplies for site activities. Rental equipment will include a portable Berkeley Surveillance and Measurement System (SAMS), a Ludlum 12 rate meter, two Ludlum Model 2221 scaler rate meters with 44-9 or 44-10 probes, Ludlum Model 2224 Alpha/Beta scaler rate meter with a 43-89 probe, Eberline $Hand_E$Count sample counting system, and possibly a Teledyne FIDLER. The CHP will also conduct an 8 hr radiation awareness class for any employees scheduled to work at the Webster Gulf Nuclear site, that have not had this training previously.

The RSO and RM will take soil and debris samples, if necessary for profiling of the site waste at Envirocare or the nonhazardous landfill during this phase of the project. If the current body of data is not sufficient to support the disposal waste profiles, the T&D Coordinator will set up a lab for the necessary analytical test such as heavy metals and alpha, beta or gamma activity surveys.

The CHP and RM will work with Earth Tech's Quality Control (QC) Manager to complete the QAPP. This plan will assure that correct sampling methods are used for collection of samples. It will also address the acceptable level of quality control for the analysis performed and the data is accurate and within acceptable quality levels. The QC Manager will perform data validation on 10% of samples collect by Earth Tech at the Webster-Gulf Nuclear site.

3.2 Mobilization

Earth Tech will mobilize a Response Manager (RM), Field Cost Accountant (FCA), Radiation Safety Officer (RSO), two Radiation Technicians (RT), three Clean-up Technicians (CT) and two Equipment Operator (ET). The site trailer will be set up and equipment inspected. Electrical power will be established for the office trailer and two mobile home trailers. Site security arrangement will be finalized. The RSO will issue personal dosimeter as outlined in the HASP.

3.2.1 Work Zones

Work zones will be established in accordance with 29 CFR 1910.120 and the site-specific HASP. The support zone (SZ) will consist of the dark asphalt area of the Medical Center parking lot and the grassy area between Blossom Street and the site. This is the uncontaminated portion of the site, which will contain Earth Tech's administrative facilities, equipment, and project supplies for decontamination, health and safety, worker breaks, personal protective equipment (PPE) and other appropriate safety support equipment. Project trailers will be located in this zone and will be supplied with electricity, water, and phone service. Portable sanitary facilities will be provided. Lined roll-off boxes will be placed in this zone to receive contaminated soil from the exclusion zone. Eating, smoking, and drinking will only be allowed within designated areas in the support zone. A shaded break area will be set up for the radiation and clean-up technicians.

The contamination reduction zone (CRZ) will be established on the asphalt area just outside the personnel fence gate. We will utilize the same area that was established during the previous removal. The CRZ is the transition zones between the exclusion zone and the support zone and will be used as a controlled area for workers to don or doff PPE and completely decontaminate, prior to entering the support zone. All exiting, screening, and decontamination of personnel and equipment from the support zone will occur within the CRZ. The decontamination process will be supervised, monitored, and documented by the radiation technician in charge of decontamination. This area will also be used for transfer of contaminated soil from the exclusion zone to the roll off container.

The existing fence surrounding the buildings will delineate the exclusion zone (EZ). Earth Tech will control access to the exclusion zone by maintaining the fence around the exclusion zone and monitoring the personnel entry gate. This administrative measure will prevent the spread of radioactive material by personnel or equipment. The personnel gate will be the only utilized EZ access. The truck access on Texas Street will be closed and locked unless a truck is moving in or out of this gate. Truck movements through this gate and throughout the Gulf Nuclear site will be supervised by an Earth Tech representative.

After the work zones are established the RM and CHP will conduct a thorough review of the HASP with all Earth Tech and Team Subcontractor Employees working at the site. Emphasis will be placed on radiation hazards, donning and doffing PPE, and minimizing cross contamination. Air monitoring will be set up prior to the work activities so baseline levels of particulates and radiation can be established.

3.2.2 Training

General and site specific training will be provided at the beginning of the project. A detailed oral review of the HASP, conducted by the RM and RSO will be completed after each site employee reads and studies the HASP. Daily safety tailgate briefings will be provided at the beginning of each workday. Training records will be continually updated to ensure that all employees are current with Hazwopper, radiation work and other site-specific training. The HASP describes and details the required training requirements in greater detail.

3.2.3 Establishment of Radiologically Controlled Area

The Webster-Gulf Nuclear Site is controlled for radiological purposes. Earth Tech will establish and maintain radiological controls for the duration of the project. Applicable documents for this purpose include Earth Tech SOP 9, Administration of Field Activities; SOP 11, Radiological Surveys and Postings; SOP 13, Radiation Training; SOP 14, Radioactive Materials Release; SOP 16, Respiratory Protection; SOP 19, Air Monitoring; and SOP 20, Site Ionizing Radiation Protection Plan.

Surface contamination guidelines are in Table 1. ^{241}Am and ^{226}Ra are Group 1 radionuclides and ^{137}Cs is a Group 4 radionuclide.

Table 1 Surface Contamination Guidelines For Unrestricted Release*

Radionuclide[a]	Allowable Total Residual Surface Contamination (dpm (100 cm^2)$^{-1}$) [b]		
	Average[c, d]	Maximum[d, e]	Removable[d, f]
Group 1: Transuranics, ^{125}I, ^{129}I, ^{227}Ac, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	**100**	**300**	**20**
Group 2: ^{natural}Th, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	**1000**	**3000**	**200**
Group 3: ^{natural}U, ^{235}U, ^{238}U, and associated decay products, alpha emitters	**5000**	**15 000**	**1000**
Group 4: Beta/gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous[g] fission) except ^{90}Sr and others noted above	**5000**	**15 000**	**1000**
Tritium (applicable to surface and subsurface)	**—**	**—**	**10 000**

3.2.4 Selecting a Reference Area

^{137}Cs are present in background because of nuclear weapons atmospheric testing fallout. ^{226}Ra is a natural constituent of background radionuclides. (^{241}Am does not occur in nature.) Establishing background concentrations that describe a distribution of measurement data is necessary to identify and evaluate contributions attributable to Webster-Gulf Nuclear operations. Determining background levels for comparison with the conditions determined in specific survey units entails conducting surveys in a reference area to define the radiological conditions of the Webster-Gulf Nuclear Site.

A reference area should have similar physical, chemical, geological, radiological, and biological characteristics as the survey units being evaluated. Reference areas provide a location for background

[a] Where surface contamination by both alpha- and beta/gamma-emitting radionuclides exists, the limits established for alpha- and beta/gamma-emitting radionuclides should apply independently.
[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrument.
[c] Measurements of average contamination should be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.
[d] The average and maximum dose rates associated with surface contamination resulting from beta/gamma emitters should not exceed 0.2 mrad h^{-1} and 1.0 mrad h^{-1}, respectively, at 1 cm.
[e] The maximum contamination level applies to an area of not more than 100 cm^2.
[f] The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. With removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct-scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
[g] This category of radionuclides includes mixed fission products, including the ^{90}Sr that is present in them. It does not apply to ^{90}Sr that has been separated from the other fission products or mixtures in which the ^{91}Sr has been enriched.

measurements that are used for comparisons with survey unit data. The radioactivity present in a reference area would be ideally the same as the survey unit had it never been contaminated.

The approximate location of a single reference area has been chosen near the Webster-Gulf Nuclear Site. This location is in the same block as the Site and has no permanent structures on it.

3.3 Long-Term Response

The focuses of the long-term response operations will be the removal of the contaminated soil and debris from the exclusion zone and a free release of the site to the Medical Center. Screening and decontamination procedures will ensure the free release of equipment utilized on the project. Our initial entries will be to establish work grids within the exclusion zone and clean the work pad within the exclusion zone. Equipment operators will work off of this pad during removal of contaminated soil. The pad will be scanned and any contaminated areas removed. Loose contamination will be removed by hand with brooms. Any fixed contamination will be removed by scrabbling the contaminated concrete portion of the pad. After the pad is decontaminated the operator will move the excavator onto the pad, while the RSO and radiation technicians continue establishment of the 3-meter square girds outlined in Earth Tech SOP7, Grid Systems and Surveys. They will measure the background radiation levels and determine the primary radionuclide in each grid square.

3.3.1 Air Sampling

Air sampling stations will be established and maintained around the site for the duration of the project in accordance with Earth Tech SOP 19. Air samplers will be operated at all times when heavy equipment movement or soil disturbance is underway. These air samples will be analyzed on site for radiological contamination. If contamination is found, work operations will be modified to lower dust levels by application of a water mist or changed operator procedures.

3.3.2 Soil

An excavator will be staged on the decontaminated concrete pad in the exclusion zone to remove the radiologically impacted soil and debris identified by the RSO, Radiation Technicians, START and the USEPA. Contaminated soil will be removed by the excavator in the EZ and transferred to the polyethylene-lined front-end loader staged in the CRZ. The front-end loader will move the material from the CRZ into the lined roll-off container in the support zone immediately adjacent to the CRZ. Polyethylene sheeting will be placed under the front-end loader during transfer, to catch any soil that is spilt in the transfer processes. Care by the operators in placing the contaminated material into the bag without spilling is critical. Soil, which is contaminated and requires removal but is low enough in activity for transport to the designated non-hazardous landfill, will be placed in a non-hazardous roll off box also located on the SZ.

Each bucket load of soil will be screened in the CRZ for radiological contamination by Earth Tech's radiation technician. The screened loads will be segregated based upon radiological activity and placed into the appropriate roll off container in the support zone. The loader bucket will be subjected to additional radiological screening and inspection following dumping of material and any switching of loads from the radiological box to the nonhazardous box. The front-end loader bucket will be decontaminated when a switch occurs or contamination is found in the bucket to prevent cross contamination.

Initially the equipment operator will be limited to removal of the top six inches of soil as designated on the site maps and confirmed by START and the USEPA. The "Removal Assessment Report" will be the primary guide for excavations confirmed by the radiation technicians in the EZ. The equipment operator will scrape using the excavator with a flat blade. Earth Tech will continually survey excavation activities with a transit, level and measuring stick to insure that the six-inch excavation depth is maintained. The radiation technician will continue to monitor radiation levels within each bucket load to determine classification of material as nonhazardous or requiring transport to Envirocare. The monitoring will also confirm that excavation activities are limited to the removal of only contaminated soil. Correlations developed by START and the USEPA will be used to relate measured activity to contaminant concentrations. Random samples will be analyzed to confirm that the viability of the correlations for removed soil.

Equipment will be operated in a manner to prevent the spread of contaminated soil being removed in the EZ to areas adjacent to this contaminated area. This will prevent cross contamination. The tracks of the excavator will only be in contact with excavated or clean areas. After the first six inches of contaminated soil is removed, Earth Tech's radiation technicians along with START personnel will survey the area after the excavated area. If additional areas require excavation the operator will use precision excavation techniques, utilizing the mini-excavator or excavator to remove soil to the required depths and perimeters identified through field radiological measurements, provided by Earth Tech and START surveys. Care will be taken to minimize cross contamination between grid squares with different predominant radionuclides. Soil will not be allowed to migrate between grid squares. Heavy equipment will not travel over unremediated areas. Radioactive waste roll off containers will be positioned so that their movement during the project is minimal. They will be placed in the support zone on the asphalt area adjacent to the CRZ.

Earth Tech will work grid by grid in an L pattern to remove the exposed layers of contaminated soil estimated at 424 cubic yards. Equipment will always be working from a clean area, so contamination of the equipment is minimized. Earth Tech's RSO or RT will continually monitor excavation activities for gamma radiation using sodium iodide detectors. Following excavation of an impacted area, EPA and START will confirm the removal of contamination through field screening and laboratory analysis. Any anomalies identified during the survey will be investigated and removed.

One exception may present itself. A grid square near the center of the Site exhibited exposure rates as high as 500 $\mu R\ h^{-1}$. Earth Tech will remediate this grid square first to keep radiation exposure as low as reasonably achievable and to lower the overall site background to enhance subsequent measurement precision and accuracy.

3.3.3 Debris

Debris will be segregated from the soil and decontaminated. Waste minimization techniques will be use to reduce disposal cost. If possible, loose contamination will be removed by dry decontamination techniques such as brushing and scraping. The radiation technician will scan the debris and classify the material as radioactive debris or nonhazardous debris. If the debris is nonhazardous, it will be staged on polyethylene sheeting until enough nonhazardous debris is collected for loading in a roll off box. If the debris is still above the acceptable level for nonhazardous debris following decontamination, the clean-up technician will again remove any loose contamination. If the contamination is fixed, the portion of the debris that is contaminated will be cut out or the nonhazardous section will be removed, reducing the amount of radioactive debris for disposal. The amount of debris requiring radiological disposal will be kept to a minimum and within the debris portion of our Envirocare profile. Earth Tech will monitor the decontamination effort to determine if the decontamination cost is exceeding the disposal cost.

The concrete pad will be the last item removed from the EZ. After all the contaminated soil is removed from the accessible grid areas, the operator will start pulling up the concrete pad with the excavator. A ram hoe attachment or a pile driver will be rented to break sections of the concrete, if the pad is to thick to pull up by the edges. Concrete removed during this operation will be placed on polyethylene sheeting and radiologically screened. The loose contamination will be removed by dry techniques and if it is necessary wet decontamination methods. The radiation technicians will screen the decontaminated concrete piece to determine if the contamination remains if the contamination is fixed or loose. Fixed contamination areas will be removed or separated from the noncontaminated areas through chipping or scabbling, significantly reducing the volume of debris that will require radioactive disposal. Care will be taken to reduce dust emissions. The contaminated soil under the concrete pad will be removed through precision techniques as outlined in the section **3.3.2 Soil**.

3.3.4 Transportation Logistics

The Webster-Gulf Nuclear site has severe space limitations, so only the minimal number of roll off boxes will be staged at the site. Trucks that are actively staging boxes in the support zone will enter the site on Blossom Street, travel across the recently seeded field area, over the ramped curb and onto the black asphalt adjacent to the CRZ.

Earth Tech will try to have only one roll-off box staged for nonhazardous soils and one box for radioactive material staged at the site. Debris boxes will only be staged when enough debris to fill a box is accumulated. The debris box will be staged, loaded and discharged.

Earth Tech proposes to utilize roll-offs for the hauling of the radioactive contaminated soil by rail or truck. The threat of cross contamination by stockpiling of soils and the small exclusion zone make loading the boxes in the support zone the best choice. Boxes will be loaded as the material is excavated. Radioactive area rope and radioactive work signs will demarcate the roll off area of the support zone.

Transportation may occur by road or rail and will be determine in the preplanning portion of the project, when competitive bids are taken for the transportation and disposal of the radioactive waste. Manifest will be completed at the site and faxed to the Transportation and Disposal Coordinator for review. The CHP will also certify each manifest. The reviewed document will be faxed to Envirocare, prior to shipment. Nonhazardous loads will be shipped on a nonhazardous manifest generated by the RM, and reviewed by the T&D Coordinator prior to presentation to the OSC for signature.

3.3.5 Cross Contamination Minimization

Cross contamination can be a serious problem during this type of removal. Earth Tech will minimize cross contamination by working the excavator and mini-excavator from clean areas within the EZ. Equipment will not track from a contaminated area to a clean area; only the active end of the equipment will be in the contaminated zone. Earth Tech will maintain the clean area within the exclusion zone; this area will originally be the concrete pad. The front-end loader will work in the CRZ and SZ. This piece of equipment will be maintained as clean with only the bucket, potentially, contacting contaminated material. Contamination will be minimized by maintaining poly sheeting on the bucket and continually scanning of the bucket by the RT in the CRZ.

Work will progress from the pad in an L shape. The remediated areas will be maintained as clean. The RTs will monitor the remediated portions of the exclusion zone and assure that they are maintained. Cleanup technicians will remove any spills immediately. Awareness by the operators and technicians to the problems of cross contamination and importance of taking quick action when a spill or a potential cross contamination event occurs is critical to reduce or eliminate cross contamination. The RM and CHP will stress the importance and steps taken to eliminate cross contamination.

3.3.6 Decontamination

A remediation project cannot be successfully completed unless an effective decontamination program is implemented to prevent both worker contamination and cross-migration of contaminants into the adjacent community. Earth Tech personnel cannot enter the exclusion zone, without first passing through the CRZ wearing the proper PPE outlined in the HASP. Crews will not directly handle or touch contaminated materials unless they are outfitted with the appropriate PPE. PPE will be visually inspected for wear, tear and proper donning by the radiation technician monitoring the CRZ and the “buddy system” within the exclusion zone. Earth Tech employees will leave the work zone if the integrity of PPE is compromised in any way. All personnel and equipment must pass through the CRZ when exiting the EZ as specified in the site-specific HASP. Upon exiting the CRZ personnel are expected to wash their hands, neck, face, and arms before eating, drinking or smoking in the designated areas of the support zone.

When any piece of heavy equipment is utilized in the EZ it will be decontaminated prior to leaving the EZ. Gross contamination will be removed by dry techniques and followed by a wet decontamination, when necessary to remove the contamination. The radiation technicians will screen the equipment to, confirm the successful removal of contamination. Decontamination will be continued until the radiation technicians release the equipment. Earth Tech will store equipment within the EZ on top of the working concrete pad during off hours.

Small pieces of equipment such as hand tools that may have come into contact with the contaminated soil, will be subjected to screening dry decontamination and wet decontamination if necessary before transitioning through the CRZ. All discarded materials, waste materials, or other objects will be handled in such a way as to minimize their volume and preclude the potential for spreading contamination, creating a sanitary hazard, or causing debris to remain on site. All potentially contaminated disposable materials (i.e., PPE, sampling instruments, etc.) will be bagged or drummed as necessary, labeled, and segregated for disposal. Rinse water used for decontamination will be placed on the contaminated soil and adsorbed. Mandated soil moisture content will not be exceeded. The contaminated particles will be removed during future excavation activities. Contaminated liquids inappropriate for this method will be drummed and disposed according to RCRA and Texas Code Statues. Earth Tech understands that accumulated water containing cesium-contaminated soil or debris will be analyzed for Cs 137 activity.

3.3.7 Site Restoration

Upon completion of the excavation activities within the exclusion zone, Earth Tech will await results from START and the USEPA OSC on the final status survey prior to backfilling and restoration activities. We will not proceed with restoration activities, until notification from the OSC, that the results of the final status survey are acceptable. Backfill material will be comparable to the surrounding soil and procured locally. Earth Tech will seek pre-approval from the OSC for compatibility to the existing material. RCRA metal results will be required from the winning soil vendor. The backfill material will also be evaluated for debris content, radioactive content, moisture content, ability to support grass growth and compatibility. The RM will visit the source location for the fill to examine the fill removal operation.

Backfill will be placed in eight-inch lifts and worked in with bulldozer. Soil will be compacted and uniformly graded to the existing contour of the site. Soil will also be graded to aid runoff to flow away from the surrounding buildings and toward the street drain. The final overall grade will be similar to the original. The final grade will be reseeded with grass and watered.

3.4 Close Out

Earth Tech's close out will begin with the radiation technicians aiding START and the USEPA with final surveys of the exclusion, contamination reduction and support zones. This will assure that all the radioactive contamination has been removed from the site.

After the surveys are completed and any additional contamination is removed, the break down of the site will commence with the office trailer and mobile homes being disconnected from the power grid. The port toilets will be returned and the water source capped. The final roll off boxes will be shipped with the nonhazardous debris and soil and the final roll off will be loaded with the last radioactive contaminated waste and discharged to Envirocare.

The FCA will focus on clearing up the pending items on the 1900-55 finalizing vendor invoices and auditing PPE inventories. The purchasing agent and FCA will close out the subcontractors that are now longer needed and will confirm with vendors that their final invoices have been submitted and that partial month rents are prorated, when acceptable by contract. The FCA will check with the vendors that all the equipment including copy and fax machines have been returned. They will arrange the demobilization travel for the Earth Tech team and finalize the last timesheets.

4.0 MANAGEMENT APPROACH AND COMMUNICATIONS

If this project is awarded to Earth Tech, we will select and assign the most qualified RM to this task order. This RM will be fully dedicated to the task order. A purchasing/subcontracting agent, T&D Coordinator ,CHP and RSO will be assigned to the project. The Program Manager and Response Manager will pull together the crew. We anticipate utilization of two equipment operators, three clean-up technicians, two radiation technicians along with the dedicated RM and RSO. Earth Tech will pull personnel from its Team Subcontractor network for this project and try to use local labor as much as possible. It is our intention to utilize the key staff developed at the Coastal Radiation Site for this removal, especially the RM and lead equipment operator. Earth Tech will provide the USEPA an experienced RM and crew.

Earth Tech utilizes scooping meetings, work plan development daily RM-OSC meetings and daily operational and the toolbox safety meetings, to ensure that communication continues successfully throughout the Webster-Gulf Nuclear project.

4.1 Scoping Meetings

Scoping meetings are held prior to and during mobilization to the site to ensure that each Earth Tech support department and team subcontractor office will be prepared to provide the needed assistance to the RM. The program manager (PM), RM, division manager, resource manager and the team subcontractors point of contact will attend these meeting, to identify specific resource requirements and potential critical paths using the staff's collective experience to respond to the USEPA needs. The RM will remain the primary point of communication with the OSC for all site-related issues.

Scoping meetings will also be held between the PM, RM, RSO, T&D Coordinator, and the Purchasing agent to develop the scope of services necessary for this response. Discussion will assure that the transportation and disposal contracts are in process and the waste profiles have been submitted. The site needs for supplies and that the other subcontracts are in place such as backfill and, heavy equipment. The PM and RM will also be meeting with the points of contact with each of the Team Subcontractors providing services to this project, to confirm arrangements for personnel and equipment supplied by the Team Subcontractors are in place.

4.2 Work Plan Development

Work plan development will continue during the site operations allowing for exchange of ideas from both the RM and OSC. As conditions change the work plan can be adapted to reflect these changes. Minor variations in quantities and approach are expected based on the indefinite nature of the work to be performed; major variations in the scope of work, quantities, or schedule will be addressed as modifications or amendments to the original work plan. The end product is an Earth Tech's plan that accomplishes the project in the most cost-effective, efficient, and safe manner.

4.3 Daily RM and OSC Meetings

While on site a daily meeting will be held between the RM and OSC. This meeting is to facilitate a mutually beneficial flow of information. Earth Tech's standard procedure is to conclude each workday with a meeting to discuss past, present and future tasks as well as any other pending issues. The attendees typically include the OSC, RM, FCA, and Foreman. The assembled staff will be able to field any specific questions the OSC may have, enabling direct reports from each facet of the project. The goal is not only to inform the OSC but to facilitate effective internal communication as well. All pertinent information discussed during the "close of business" meetings will be summarized into a daily report and submitted to the OSC with the 1900-55 on the following morning. The daily report will include the following information and sections:

Primary health and safety concerns of project tasks
Subcontracting needs (if any)
List of all site personnel and their role in each task
List of off-site personnel, hours worked, and comments (presented as a separate report if necessary)
List of all equipment and its role in each task
General comments regarding site
Problems, issues, concerns, resolutions
Percent of completion of each task
Cost to date
Percent of ceiling remaining
Acknowledgment by RM
Acknowledgment by OSC, if possible.

4.4 Site Command Structure

The RM will head Earth Tech's site command structure. He is the main point of contact for the OSC. The RM will be responsible for direct supervision of the cleanup personnel, their development, the execution of the work plan and subcontracts. He will assure that the Earth Tech on-site team is effective in caring out the work plan objectives and procedures. He will maintain communication with the Earth Tech support staff to assure that all necessary subcontracts, especially the contracts for transportation and disposal are completed. He will be the primary contact for communication with local vendors, the foreman, operators and crew.

The RSO will assist the RM with his duties to allow for successful removal of the contaminated soil and debris and restoration of the site. The RSO working with the offsite CHP will be the technical expert to accomplish this task with minimal cross contamination and small environmental impact. The RSO will also be the onsite safety officer assuring that the HASP is strictly followed and that changing conditions are address with modifications to the HASP. He will modify the HASP with approval of the Earth Tech Health and Safety Department, when necessary and will updated the HASP throughout the project. Safety is everyone's responsibility but the RM and RSO need to assure that the HASP is followed and that the crew has a good understanding of the hazardous at the site.

The foreman will report directly to the RM. His responsibilities include running the crew and completing tasks as the RM assigns them. The Foreman will provide a communication avenue between the crew, RM, and RSO.

Equipment operators (EQ) familiar with radiological cleanup are critical for this response. He will report to the foreman and RM on the best approaches for the use of equipment to accomplish the work objectives with minimal cross contamination and environmental impact.

The clean-up technicians (CT) will be responsible for completing task as the Foreman and RM assign them. They will aid in removal of the contaminated soil and debris. They will have a good understanding of the HASP and Earth Tech's Safety and Radiological SOP's.

Table 2 Proposed Webster-Gulf Nuclear Team

Title	Name
On-Scene Coordinator	Greg Fife
Response Manager	Walter Johnson
Transportation and Disposal Coordinator	Dawn Blevins
Radiation Safety Officer	Charles Williams
Field Cost Accountant	Mindy Miller
Purchasing/Subcontracting Agent	Cathy Sheffield
Foreman	Michael Brooks
Equipment Operator	Steve Smith- ASCO Environmental
Radiation Technicians	Earth Tech
Clean-up Technicians	Earth Tech and ASCO

5.0 RESOURCES AND SCHEDULING

To provide EPA with a cost-effective and timely approach to addressing the safety, health, and environmental hazards associated with the Webster-Gulf Nuclear facility, Earth Tech will mobilize an RM, CHP, 2 EQ, 2 RT, a foreman, FCA and 3 CT. The crew will be mobilized from local locations as much as possible. Earth Tech has some staff in Houston and ASCO Environmental has a large pool of workers in Lake Charles, La. The crew will work daytime hours 0700 to 1730 and will have subcontracted security services during non-working hours.

After arriving on site, the RM, RSO, and FCA will meet with the OSC to determine and address the immediate needs and concerns at the site based on the scope of work as presented in this work plan. Once all preliminary preparations have been completed and the full scope of services has been finalized, additional personnel such as the foreman, EQ and CT will be assigned as necessary to prioritize and implement the tasks outlined in this plan. Likewise, the necessary materials and equipment to accomplish completion of the task order will be mobilized to the site based on priority of utilization for each specific task. The necessary personnel, equipment, and materials will be mobilized as required for each task. To ensure site operations are effective and cost-efficient, the Foreman and RM will review resources on site, after the completion of each designated task, to assess their future needs and the possibility of increasing and/or reducing staff to maximize task performance and efficiency. Tasks will be performed concurrently to facilitate an effective cost management approach to addressing site hazards. The tasks as presented and the diversified staff that have been identified provide the flexibility to switch between tasks if unforeseen circumstances cause project delays. This ability provides the RM and OSC the opportunity to maximize the progress of the response action while maintaining schedule and budget.

Table 3 Resources

Personnel	Equipment	Materials
Long-Term Response		
Response Manager Radiation Safety Officer Field Cost Accountant Foreman Equipment Operator (2) Radiation Technicians (2) Clean-up Technicians (3)	Rental Cars (2) Truck (2) Office Trailer Fax Copy Machine Storage Trailer Computers (3) Excavator Forklift Mini-Excavator Front end loader Scrabbling Unit Air Sampling Pumps SAMS Ludlum 12 Ludlum 19A Ludlum 12-4 Ludlum 2221 Ludlum 2224	Personal Protective Equipment Hand Tools Drums Polyethylene Sheeting Drum Liners

	Ludlum 43-89 Ludlum 44-10 Ludlum 44-9 ThermoEberline Hand$_E$Count Teleydyne Fidler Generators	

Earth Tech has prepared an aggressive schedule that addresses the requirements necessary to remove the contaminated soil and debris from the Webster-Gulf Nuclear Site.

Table 4 Time Line

Task	Time Allotted
Preplanning	30 days
Mobilization	2 days
Long Term Response	
Site preparation	5 days concurrent with Mobilization
Soil Removal	50 days
Debris Removal	Concurrent with Soil
Site Restoration	5 days
Demobilization	2 days concurrent with Site Restoration
Close Out	5 days concurrent with Site Restoration

6.0 WASTE MANAGEMENT REQUIREMENTS

The waste disposal activities ensure the proper off-site disposal of wastes. Activities include the identification, sampling and characterization of wastes for profiling and procurement. Our T&D coordinator is responsible for the waste profiles and getting approvals at the winning disposal vendors. The T&D coordinator will also participate with the purchasing agent and RM in preparing documents for the transportation and disposal procurements. The Earth Tech staff will pursuit the most cost effective disposal options for Webster-Gulf Nuclear waste including rail transport of radioactive soil and debris.

Properly executed, the waste disposal activities will minimize the off-site migration of contaminants through appropriate engineering controls and proper employee work practices. Site operations will be planned and prioritized to minimize the generation of radioactive wastes and use work practices to maximize the nonhazardous waste streams and minimizing the amount of material that must go to Envirocare.

Time spent to coordinate and implement the various waste disposal options is incorporated in the duration of preplanning activity. The following is a summary of the expected waste streams pending final analysis and disposal acceptance:

7.0 SUBCONTRACTING

In addition to performing the customary duties of a field clerk, the FCA will support the RM in identifying appropriate team and subcontracted services. Earth Tech's Purchasing/Subcontracting Department will in turn help the RM and FCA obtain vendors and subcontractors for the site. The Purchasing/Subcontracting Department will take advantage of blanket ordering agreements, task-order-based subcontracts, and strategic vendors to fill the requirements of the site. The RM will identify the appropriate vendors and subcontracted and team subcontractor resources required for this project. Specific to this response action, every effort will be made to seamlessly procure services from local subcontractors and vendors.

7.1 Team Subcontractors

Due to the location of this delivery order, Earth Tech foresees the need for team subcontractors. The Program Manager will coordinate with the three available ERRS team subcontractors for this project to outline availability of local labor and experience with radiological removals: Earth Tech's active team subcontractors are ASCO Environmental, V-Tech Environmental, Chemical Response and Remediation Contractors, Inc. Earth Tech is in the process of adding Hulcher Services as a team subcontractor. If approved by the USEPA Contracting Officer this company will also be available to support this project and has a local office in Houston. Subcontract agreements in the form of Master Service Agreements are actively in place with established rates for the secured and pending team subcontractors.. The team subcontractors used for this delivery order will be activated through their Master Services agreement by means of a written task order.

7.2 Non-Team Subcontractors

The major non-team subcontracting needs for the Webster-Gulf Nuclear Site will be analytical laboratories, transportation, disposal and security companies. Earth Tech has identified responsible laboratories throughout the region and has existing Master Service Agreements standing for the ERRS-6 contracts. These approved laboratories will be subcontracted by using a competitive procurement process and activated by a task order to their standing Master Services Agreement. The T&D coordinator will generate a scope of work for the anticipated required analysis for this project. This scope of work will be sent to approved laboratory facilities to solicit a quote for the requested services. This method of procurement will be used to achieve the best pricing for the client. Earth Tech anticipates that the following analytical services will be required:

- Standard analysis for hazardous determinations and disposal profiles.
- Alpha, Beta and Gamma Surveys for radiological disposal

7.2.1 Transportation and Disposal

Earth Tech as part of the preplanning task order is identifying potential vendors for the nonhazardous and radiological waste for this project. Estimated pricing will be obtained for the accompanying cost estimate. However, our standard subcontracting methods will utilized to procure transportation and disposal activities. Once the laboratory has provided analytical results or the analytical results submitted by START and the USEPA are sufficient to profile the waste, the T&D Coordinator, RM and purchasing agent will develop an Invitation for Bid for the transporters and disposal companies outlining our requirements and their responsibilities. A solicitation will be sent out to the approved subcontractors able to receive the waste. All responses will be reviewed and the contract will be awarded to the lowest responsive bidder.

7.2.2 Security

Earth Tech will obtain security services via a competitive procurement for after-hours security during this removal activity. Local companies will be solicited to eliminate costs associated with lodging and per diem. A responsibility determination will be performed on the awarded security subcontractor. This responsibility determination will be written into the IFB and will ask for information from the potential vendors how there employees are screened for work as security guards. Once a security company has been selected, a subcontract with all the applicable FAR and prime contract flow down clauses will be executed including conflict of interest determination.

7.3 Vendors

Earth Tech will endeavor to utilize local vendors and subcontractors, as well as small, woman-owned, and small disadvantaged businesses (SB/WOB/SDB). The primary services to be procured from vendors during this project are lodging, heavy equipment, and backfill.

The RM will direct the FCA to conduct a search of local hotels in the area. Upon completion of the search, a government rate will be negotiated for the number of rooms and time period needed to complete site operations. Hotel services will be arranged on a direct-bill payment system so as not to burden the site administrator with unnecessary paperwork. Local resources will be used based on a pertinent experience and availability to reduce the overall cost to the government.

Appendices

Appendix A

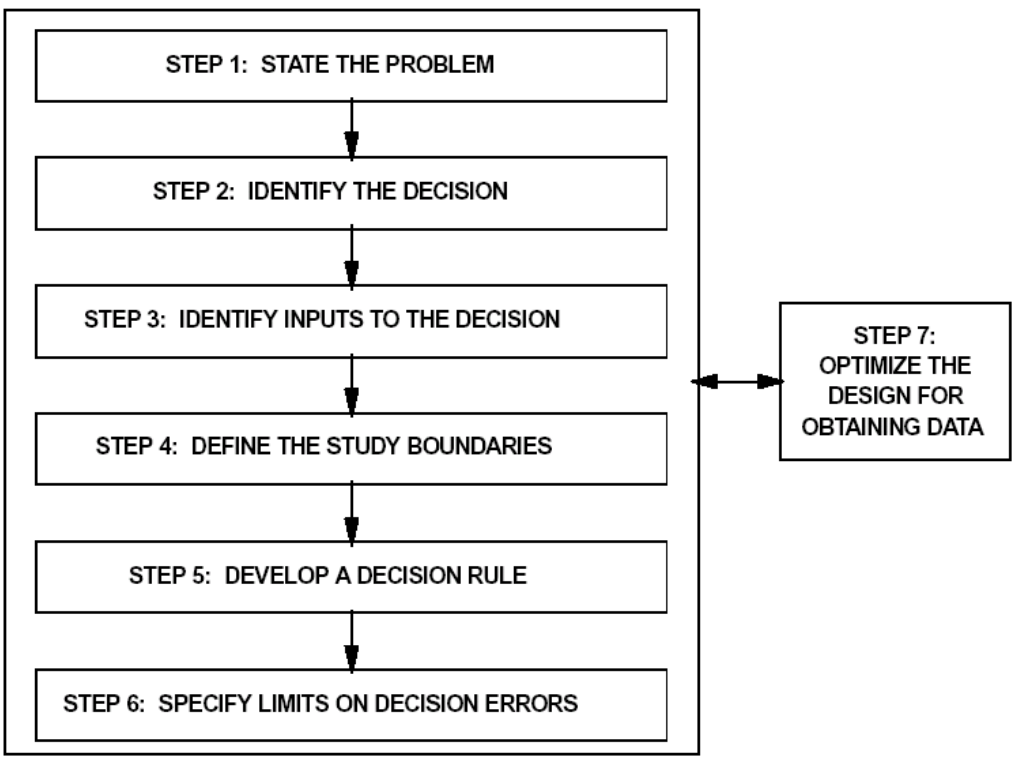
MARSSIM Data Quality Objectives

MARSSIM

Data Quality Objectives

Survey planning uses the data quality objectives (DQO) process to ensure that survey results are of sufficient quality and quantity to support the final decision. According to *MARSSIM*, the DQO process is a series of planning steps based on the scientific method for establishing criteria for data quality and developing survey designs. Planning radiation surveys using the DQO process improves survey effectiveness and efficiency and, thereby, the defensibility of decisions. This minimizes expenditures related to data collection by eliminating unnecessary, duplicative, or overly precise data.

Using the DQO process ensures that the type, quantity, and quality of environmental data used in decision-making will be appropriate for the intended application. *MARSSIM* supports the use of the DQO process to design surveys for input to both evaluation techniques (elevated measurement comparison and the statistical test). The DQO process provides systematic procedures for defining the criteria that the survey design should satisfy, including what type of measurements to perform, when and where to perform measurements, the level of decision errors for the survey, and how many measurements to perform. The DQO process consists of seven steps.



The output from each step influences the choices that will be made later in the Process.

Even though the DQO process is depicted as a linear sequence of steps, in practice it is iterative; the outputs of one step may lead to reconsideration of prior steps. For example, defining the survey unit boundaries may lead to classification of the survey unit, with each area or survey unit having a different decision statement. This iteration is encouraged since it ultimately leads to a more efficient survey design.

The first six steps of the DQO process produce the decision performance criteria that are used to develop the survey design. The final step of the DQO process develops a survey design based on the DQOs.

A.1 State the Problem

A.1.1 Members of the planning team and stakeholders

Earth Tech has developed the work plan based on information provided by START and the USEPA. Stakeholders include members of the local Webster community.

A.1.2 Identify the primary decision-maker or decision-making method

The decision-makers for acceptability of this work plan are the USEPA, and TDH, personnel.

A.1.3 Develop a concise description of the problem

Radioactive contamination in the form of ^{241}Am, ^{137}Cs, ^{192}Ir, ^{226}Ra (and its progeny), and ^{153}Gd is present in the soil at the Webster site at levels greater than allowed by TAC 289 (see Table A-1) at a depth no greater than 18 inches (45 cm).

A.1.4 Available resources and relevant deadlines

Earth Tech can provide personnel experienced in environmental health physics measurements and remediation. Equipment in the Earth Tech inventory includes hand-held alpha and beta survey instruments, sodium iodide (thallium activator) (NaI(Tl)) and Geiger-Muller (GM) detectors for gamma radiation, neutron counter(12-4) detector for neutron radiation, and NaI(Tl) and high purity germanium (HPGe) gamma spectroscopy systems (see Appendix B). Earth Tech also has a portable laboratory station that can be used to count swipes and perform gamma spectroscopy measurement.

Accredited radioanalytical laboratory support is available from commercial radioanalytical laboratories such as STL located in Richland, Washington.

A.2 Identify the Decision

A.2.1 The principal study question

The principal study question is, "What remediation, if any, is required after contaminated soil identified by the characterization survey has been removed?" This question is answered with information supplied by remedial action support surveys.

Remedial action support surveys are conducted to support remediation activities; however, in addition they can determine when a site or survey unit is ready for its final status survey and provide updated estimates of site-specific parameters to use for planning the final status survey.

A.2.2 Choices for actions that could result from resolution of the principal study question

Alternative actions depend on the levels of contamination found relative to the derived concentration guideline limits (DCGLs).

A DCGL, based on pathway modeling, is the uniform residual radioactivity concentration level within a survey unit that corresponds to a release criterion (for example, a regulatory limit in terms of dose or risk) for a certain radionuclide. The DCGL may be obtained using regulatory agency guidance based on default parameters or from site-specific pathway modeling. In either case, the DCGL is based on the spatial distribution of the contaminant, and each derivation can produce different values depending on the specific radionuclide distribution and pathway modeling.

Action choices that could result from resolution of the principal study question are listed in Table A-1.

Table A-1. Action choices.

Typical Level of Contamination	Possible Action
Less than DCGLs.	No further action.
On the order of DCGLs.	Spot remediation with resurvey.
Greater than DCGLs	Continued remediation.

A.2.3 Decision statement

The decision statement is, "Determine whether each survey unit meets the DCGLs for the radioisotopes of concern and that contamination has been reduced to background levels when it is technically or economically impractical to do so."

For the purposes of this proposed work plan, the DCGLs to be used were derived from 25 TAC 289 and are listed in Table A-2.* In accordance with 25 TAC 289, it is noted that every effort shall be made to reduce contamination to background levels and that the limits in this table only apply when it is technically or economically impractical to do so. Also, where combinations of radionuclides are involved, the sum of the ratios between the concentrations present and the limits specified in paragraph (2) of this subsection shall not exceed one.

Table A-2. DCGLs.

Radioisotope	DCGL (pCi g–1)
^{241}Am	6
^{137}Cs	40
^{226}Ra in top 15 cm of soil	5
^{226}Ra below top 15 cm of soil	15

* Results shown in the pending report of the characterization survey may require revision to this set of radioisotopes of concern.

The radioisotopes, ^{153}Gd (half-life = 241.6 days) and ^{192}Ir (half-life = 73.8 days), are not included in Table A-2 and will not be considered further for two reasons. First, many half-lives have elapsed for each of them since production at the site ceased in 1987, so their soil concentrations are expected to be negligible, if not immeasurable, in 2003. Second, they are both gamma emitters, as are ^{241}Am, ^{137}Cs, ^{241}Am, and ^{226}Ra. Detection and measurement of gamma rays from ^{241}Am, ^{137}Cs, ^{226}Ra, and ^{226}Ra progeny will also include detection and measurement of whatever gammas from ^{153}Gd and ^{192}Ir may be present.

A.3 Identify Inputs to the Decision

A.3.1 Identify information required to resolve the decision statement.

Permissible radioactive contamination guidelines will be based on 25 TAC 289 and be in units of picocuries per gram (pCi g^{-1}). The extent of the contamination was determined during the characterization survey (report is pending). The degree of soil contamination in units of picocuries per gram for the radioisotopes of concern, ^{241}Am, ^{137}Cs and ^{226}Ra, must be known to resolve the decision statement.

A.3.2 Determine sources for each item of information.

Contamination is presumed to be everywhere on the site. The primary sources for required information will be the characterization report and the *in situ* detection and measurement of gamma rays before, during, and after remediation.

A.3.3 Identify the information needed to establish the DCGLs based on the release criterion.

The 25 TAC 289 establishes the DCGLs with the additional guidance that remediation shall be to background levels if it is technically and economically practical to do so.

A.3.4 Confirm that appropriate measurement methods exist to provide the necessary data.

Detection of gamma rays and measurements of their count rates is an acceptable method for performing remedial action support surveys for ^{241}Am, ^{137}Cs, and ^{226}Ra soil contamination with many precedents. Earth Tech will use field instruments for the detection of low-energy radiation (FIDLERs) to detect and measure ^{241}Am soil contamination and Ludlum model 44-10 gamma scintillators to detect and measure ^{137}Cs and ^{226}Ra soil contamination.

A.3.5 Informational inputs needed to resolve the decision statement

Since 25 TAC 289 specifies that remediation shall be to background levels if it is technically and economically practical to do so, a knowledge of background levels for the Webster-Gulf Nuclear site is required. Earth Tech will choose a reference area near the site that is unaffected by Webster-Gulf Nuclear operations and measure gamma background with FIDLERs and Ludlum model 44-10 gamma scintillators.

Earth Tech will also make measurements of exposure rates at the reference area and at the Webster-Gulf Nuclear site using a Ludlum model 19A MicroR Meter. These measurements will be for informational purposes only, because the Ludlum model 19A MicroR Meter does not have a linear response to gamma ray energies *versus* exposure rate. Remediation decisions will be based on FIDLER and Ludlum model 44-10 gamma scintillator measurements.

A.3.6 Environmental variables or characteristics that will be measured

Gamma count rates will be determined with a FIDLER and with a Ludlum model 44-10 gamma scintillator in the Webster-Gulf Nuclear site and in a nearby reference area for the purposes of remedial action support surveys. Exposure rates will be measured with a Ludlum model 19A MicroR Meter in the Webster-Gulf Nuclear site and in a nearby reference area for information purposes.

A.4 Study Boundaries

A.4.1 Webster-Gulf Nuclear Site

The characterization report will show how and where radioactive contamination is distributed at the site. Remediation and remedial action support survey activities will be confined to the site except for background measurement taken at the reference area.

A.4.2 Reference Area

An appropriate reference area with about the same size and shape as the Webster-Gulf Nuclear Site will be chosen following guidance in *MARSSIM* section 4.5. The appropriateness of the selection will be evaluated following guidance in *MARSSIM* chapter 8.

A.5 Decision Rules

FIDLER and Ludlum model 44-10 gamma scintillator static measurements will be compared to the average backgrounds as measured with the same instruments in the reference area by using the minimum detectable concentrations (MDCs) for these instruments.

The expression for MDC that will be used throughout this plan (from NUREG-1507, equation 3-10) is given as:

$$\mathrm{MDC} = \frac{3 + 4.65\sqrt{C_B}}{KT}$$

where C_B is the background count in time, T, for paired observations of the sample and blank B. For example, if ten 1-minute repetitive observations of background were performed, C_B would be equal to the average of the ten observations and T is equal to 1 minute. The quantities encompassed by the proportionality constant K such as the detection efficiency and probe geometry, should also be average, "well-known" values for the instrument.

The derivation of this expression assumes that Type I and Type II decision errors are both equal to 5 percent.

Results that are more than the MDC will be considered as “above background” and further remediation may be necessary if it is technically and economically practical to do so. If it is not technically and economically practical to perform further remediation (for example, the scope of work specifies that remediation is only for the top 6-18 inches of soil), then the count rates above background will be converted to an estimated soil concentration in picocuries per gram using the conversion factors applied in determining MDCs. If results of this conversion indicate that the limits in Table A-2 are met, then no further action shall be required. If the limits in Table A-2 are exceeded, Earth Tech will refer the question to EPA for resolution.

A.5.1 Specify Limits on Decision Errors

The null hypothesis is that A Type I decision error occurs when the null hypothesis is rejected when it is true and is sometimes referred to as a false positive error. The probability of making a Type I decision error, or the level of significance, is denoted by alpha (α). Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis and is referred to as the size of the test.

A Type II decision error occurs when the null hypothesis is accepted when it is false. This is sometimes referred to as a false negative error. The probability of making a Type II decision error is denoted by beta (β). The term ($1 - \beta$) is the probability of rejecting the null hypothesis when it is false and is referred to as the power of the test.

Decisions made from the results of this survey will be based primarily on gamma detection and measurements with FIDLER and Ludlum model 44-10 gamma scintillator instruments. This means that application of the decision rule in section 1.2.5 with uncertainties at the 95 percent confidence level will provide a 5 percent probability for both alpha and beta, neglecting the uncertainty in the DCGLs.

A.5.2 Optimize the Design for Obtaining Data

The Gulf Nuclear Site was been divided into 3-meter square grids for the characterization survey. Earth Tech will grid the Site and the reference area similarly.

A.6 Reference Area

Gamma background in the reference area will be determined by taking ten one-minute counts at the center of each grid square with each instrument. The average of all the counts and an uncertainty in that average will be calculated and designated as the background for the Webster-Gulf Nuclear Site. An exposure rate measurement with a Ludlum model 19A MicroR Meter will als Determine sources for each item of information purposes.

A.6.1 Webster-Gulf Nuclear Site

A.6.1.1 Before remediation begins

Earth Tech will take measurements in each grid square with the Berkeley Nucleonics Model 935 Portable Surveillance and Measurement System (SAMS) in an attempt to identify the predominant radionuclide in the grid square. If adequate count rates are available, the SAMS can identify quantitatively the source of the radiation. Soil with radioactive contamination consisting primarily of ^{241}Am must be segregated for disposal purposes from that with radioactive contamination consisting primarily of ^{137}Cs or ^{226}Ra.

An exposure rate measurement with a Ludlum model 19A MicroR Meter will also be taken at the center of each grid square for information purposes.

A.6.1.2 After the top six inches of soil have been removed

Earth Tech will scan each grid square with the FIDLER and Ludlum model 44-10 gamma scintillator instrument. A static measurement will be taken at the point of the highest count rate within the grid for each instrument; note that the point with the highest count rate within the grid square may not be the same point for both instruments.

If both measurements indicate that radioactive contamination is less than the MDC for each instrument, then no further remediation in that grid square is necessary.

Otherwise, Earth Tech will take measurements in the grid square with the SAMS in an attempt to identify the predominant radionuclide in the grid square. Earth Tech will remove the next six inches of soil and put it into the appropriate waste container.

An exposure rate measurement with a Ludlum model 19A MicroR Meter will also be taken at the center of each grid square for information purposes.

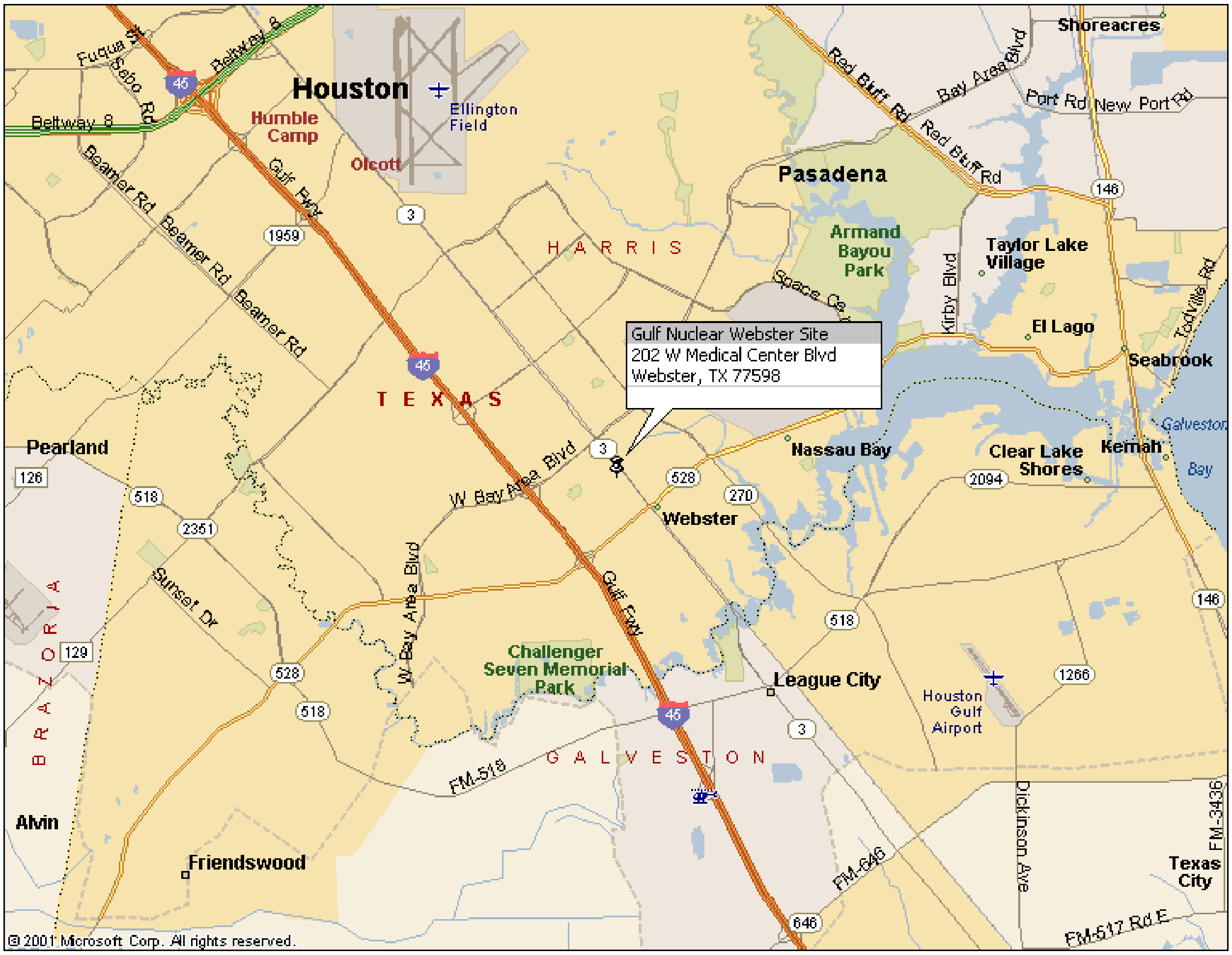


Figure A-1. Webster-Gulf Nuclear Site, Webster, Texas.

Appendix B

Procedures and Practices

B.1 APPLICABLE FIELD PROCEDURES AND PRACTICES

B.1.1 Health and safety

The HASP is a separate document and will be based on the work plan if the project is awarded to Earth Tech. The RSO and RM will be designated prior to the start of field operations and will be responsible for implementation of the HASP during field operations. Also, see SOP 20, *Site Ionizing Radiation Protection Plan*, in Appendix B.

All personnel involved in or present during field operations will be required to follow all rules and requirements of the HASP. Health and safety requirements are based on modified Level D personal protective equipment. All civilian personnel handling samples or present at locations where heavy equipment, such as drilling rigs, are in operation must have current 40-hour Occupational Safety and Health Administration training in accordance with Title 29, Code of Federal Regulations, Part 1910, § 1910.120.

B.1.2 Gamma measurements

See SOP 1, *Portable Detection Equipment*; SOP 2, *Scaler Operations*; SOP 11, *Radiological Surveys and Postings*; and SOP 20, *Site Ionizing Radiation Protection Plan*, in Appendix B for gamma measurement techniques.

B.1.3 Equipment contamination surveys and release

See SOP 4, *Equipment Decontamination*, in Appendix B for equipment decontamination procedures.

B.1.4 Wipe tests

See SOP 12, *Swipe Samples*, in Appendix B for wipe test procedures.

B.1.5 Radiation instrument calibration and maintenance

See SOP 1, *Portable Detection Equipment*, and SOP 2, *Scaler Operations*, in Appendix B.

All instruments shall be calibrated by a qualified calibration/repair facility at least annually in accordance with manufacturers' instructions. Sources used in calibration will be National Institute of Standards and Technology-traceable. A calibration certificate will be maintained onsite for each instrument and included in the project final report.

Each instrument shall be checked at the beginning, middle, and end of each shift with check sources to verify that its response is within ± 20 percent of the value established by the calibration laboratory for that instrument/check source/geometry combination. If the instrument fails the post-survey source check, all data collected during that time with the instrument must be reviewed and adjusted or discarded as appropriate. The affected data shall be flagged and later studied by the RSO to determine if they are useable.

Each item of survey equipment shall meet function response requirements before and during its use. Control charts shall be maintained to monitor the performance of field instruments for the duration of the project. If survey equipment requires repair during a workday, it shall be repaired and its proper function verified before it is returned to use.

B.2 Radiological Standard Operating Procedures

SOP 1 *Portable Detection Equipment*
SOP 2 *Scaler Operations s/b Swipe Counter*
SOP 4 *Equipment Decontamination*
SOP 6 *General Radiological Equipment Checklist*
SOP 7 *Grid Systems and Surveys*
SOP 9 *Administration of Field Activities*
SOP 10 *Low Level Radioactive Waste Disposal*
SOP 11 *Radiological Surveys and Postings*
SOP 12 *Swipe Samples*
SOP 13 *Radiation Training*
SOP 14 *Radioactive Materials Release*
SOP 15 *Pre-Loading and Release*
SOP 16 *Respiratory Protection*
SOP 17 *Hazard Communication*
SOP 19 *Air Monitoring*
SOP 20 *Site Ionizing Radiation Protection Plan*
SOP 21 *Donning and Doffing PPE*

Appendix C

Pertinent Extracts from 25 TAC 289

Pertinent Extracts from 25 TAC 289

§289.202(ddd) Radiological requirements for license termination.

(1) General provisions and scope.

(A) The requirements in this section apply to the decommissioning of facilities licensed in accordance with §289.252 of this title (relating to Licensing of Radioactive Material), §289.254 of this title (relating to Licensing of Radioactive Waste Processing and Storage Facilities), §289.255 of this title (relating to Radiation Safety Requirements and Licensing and Registration Procedures for Industrial Radiography), and §289.258 of this title (relating to Licensing and Radiation Safety Requirements for Irradiators). ….

…

(C) After a site has been decommissioned and the license terminated in accordance with the requirements in the subsection, the agency will require additional cleanup if it determines that the requirements of the subsection were not met and residual radioactivity remaining at the site could result in significant threat to public health and safety.

(D) When calculating TEDE to the average member of the critical group, the licensee shall determine the peak annual TEDE dose expected within the first 1,000 years after decommissioning.

(2) Radiological requirements for unrestricted use. A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are ALARA. Determination of the levels that are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

(3) Alternate requirements for license termination.

(A) The agency may terminate a license using alternate requirements greater than the dose requirements specified in paragraph (2) of this subsection if the licensee does the following:

(i) provides assurance that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 1 mSv per year (100 mrem per year) limit specified in subsection (o) of this section, by submitting an analysis of possible sources of exposure;

(ii) reduces doses to ALARA levels, taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal; and

(iii) has submitted a decommissioning plan to the agency indicating the licensee's intent to decommission in accordance with the requirements in §289.252(l)(7) of this title, and specifying that the licensee proposes to decommission by use of alternate requirements. The licensee shall document in the decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that advice. In seeking such advice, the licensee shall provide for the following:

(I) participation by representatives of a broad cross section of community interests who may be affected by the decommissioning;

(II) an opportunity for a comprehensive, collective discussion on the issues by the participants represented; and

(III) a publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues.

(B) The use of alternate requirements to terminate a license requires the approval of the agency after consideration of the agency's recommendations that will address any comments provided by the EPA and any public comments submitted in accordance with paragraph (4) of this subsection.

(4) Public notification and public participation. Upon receipt of a decommissioning plan from the licensee, or a proposal from the licensee for release of a site in accordance with paragraph (3) of this subsection, or whenever the agency deems such notice to be in the public interest, the agency will do the following:

(A) notify and solicit comments from the following:

(i) local and state governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and

(ii) the EPA for cases where the licensee proposes to release a site in accordance with paragraph (3) of this subsection; and

(B) publish a notice in the Texas Register and a forum, such as local newspapers, letters to state of local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties.

…

§289.202(eee) Limits for contamination of soil, surfaces of facilities and equipment, and vegetation.

(1) No licensee shall possess, receive, use, or transfer radioactive material in such a manner as to cause contamination of surfaces of facilities or equipment in unrestricted areas to the extent that the contamination exceeds the limits specified in subsection (ggg)(6) of this section.

(2) No licensee shall possess, receive, use, or transfer radioactive material in such a manner as to cause contamination of soil in unrestricted areas, to the extent that the contamination exceeds, on a dry weight basis, the concentration limits specified in:

(A) subsection (ggg)(8) of this section; or

…

(3) Where combinations of radionuclides are involved, the sum of the ratios between the concentrations present and the limits specified in paragraph (2) of this subsection shall not exceed one.

(4) Notwithstanding the limits specified in paragraph (2) of this subsection, no licensee shall cause the concentration of radium-226 or radium-228 in soil in unrestricted areas, averaged over any 100 square meters (m^2), to exceed the background level by more than:

(A) 5 picocuries per gram (pCi/g) (0.185 becquerel per gram (Bq/g)), averaged over the first 15 cm of soil below the surface; and

(B) 15 pCi/g (0.555 Bq/g), averaged over 15 cm thick layers of soil more than 15 cm below the surface.

…

§289.202(ggg)(8) Soil contamination limits for selected radionuclides (for use in subsection (ddd) of this section).

Isotope	Concentration Limits* (picocuries per gram)
…	…
Amercium-241	6
…	…
Cesium-137	40
…	…

* It must be emphasized that every effort must be made to reduce contamination to background levels and that the limits in this table only apply when it is technically or economically impractical to do so.

Appendix D

Instrumentation

D.1 Berkeley Nucleonics Model 935 Portable Surveillance and Measurement System (SAMS)

The SAMS contains a 2-inch × 2-inch NaI(Tl) detector with built-in high voltage supply, preamplifier, amplifier, analog-to-digital converter, multichannel analyzer, and computer-controlled hardware and software. It is capable of performing onsite gamma spectroscopy, dose-rate measurements, and radioisotope identification and quantification.

D.2 Ludlum Model 12 Ratemeter

COMPATIBLE DETECTORS: G-M, proportional, scintillation
METER DIAL: 0 - 500 cpm, 0 - 2.5 kV, BAT TEST (*others available*)
MULTIPLIERS: × 1, × 10, × 100, × 1000
LINEARITY: Reading within plus or minus 10 percent of true value with detector connected
CONNECTOR: Series "C" (*others available*)
AUDIO: Built in unimorph speaker with ON/OFF switch (*greater than 60 dB at 2 feet*)
CALIBRATION CONTROLS: Accessible from front of instrument (*protective cover provided)*
HIGH VOLTAGE: Adjustable from 200 – 2500 volts (*can be read on meter*)
DISCRIMINATOR: Adjustable from 2 – 60 mV
RESPONSE: Toggle switch for FAST (4 s) or SLOW (22 s) from 10 percent to 90 percent of final reading
RESET: Push-button to zero meter
POWER: 2 each D cell batteries (*housed in sealed compartment that is externally accessible*)
BATTERY LIFE: Typically 600 hours with alkaline batteries (*battery condition can be checked on meter*)
METER: 2.5" (6.4 cm) arc, 1 mA analog type
CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint
TEMPERATURE RANGE: –4° F (–20° C) to 122° F (50° C)
SIZE: 6.5 inches (16.5 cm) height × 3.5 inches (8.9 cm) width × 8.5 inches (21.6 cm) length
WEIGHT: 3.5 lbs (1.6 kg) including batteries

D.3 Ludlum Model 19A MicroR Meter

WORKING ENVIRONMENT: Splash proof shields for outdoor use
INDICATED USE: Low level gamma survey
DETECTOR: 1-inch × 1-inch sodium iodide NaI(Tl) scintillator
SENSITIVITY: Typically 175 cpm (μR h^{-1})$^{-1}$ (^{137}Cs gamma)
ENERGY RESPONSE: Energy dependent
METER DIAL:0 – 500 μR h^{-1} dual colored logarithmic scale, BAT TEST
ALARM: Indicated by red lamp and audible tone (Alarm audio overrides the audio ON/OFF switch)
LIGHT: Push-button to activate
LINEARITY: Reading within ± 10 percent of true value
AUDIO: Built in unimorph speaker with ON/OFF switch (greater than 60 dB at 2 feet)
CALIBRATION CONTROLS: All calibration controls are internal
RESPONSE: Dependent on number of counts present (typically not greater than 7 seconds from 10 percent to 90 percent of final reading)
RESET: Push-button to zero meter
POWER: 2 each “D” cell batteries (housed in sealed compartment that is externally accessible)
BATTERY LIFE: Typically 600 h with alkaline batteries (battery condition can be checked on meter)
METER: 2.5 inches (6.4 cm) arc, 1 mA analog type
CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint
TEMPERATURE RANGE: –4° F (–20° C) to 122° F (50° C)
SIZE: 7.8 inches (19.8 cm) height × 3.5 inches (8.9 cm) width × 8.5 inches (21.6 cm) length
WEIGHT: 4.5 pounds (2.1 kg) including batteries

D.4 Ludlum Model 43-89 Alpha/Beta Scintillator

INDICATED USE: Alpha-beta survey
SCINTILLATOR: ZnS(Ag) adhered to 0.010-inch thick plastic scintillation material
WINDOW: Typically 1.2 mg cm^{-2} aluminized Mylar
WINDOW AREA: Active – 125 cm^2; Open – 100 cm^2
EFFICIENCY (4π geometry): Typically 16 percent – ^{239}Pu; 5 percent – ^{99}Tc; 16 percent – $^{90}S/^{90}Y$
BACKGROUND: Alpha - Less than 3 cpm; Beta - Typically 300 cpm or less (10 μR h^{-1} field)
NON-UNIFORMITY: Less than 10 percent
CROSS TALK: Alpha to Beta - Less than 10 percent; Beta to Alpha - Less than 1 percent
COMPATIBLE INSTRUMENTS: Model 2224, 2360, 2929
TUBE: 1.5 inches (3.8cm) diameter magnetically shielded photomultiplier
OPERATING VOLTAGE: Typically 500 - 1200 volts
DYNODE STRING RESISTANCE: 100 megohms
CONNECTOR: Series C (others available)
CONSTRUCTION: Aluminum housing with beige polyurethane enamel paint
TEMPERATURE RANGE: -4° F(-20° C) to 122° F(50° C)
SIZE: 5.5 inches (13.9 cm) height × 4 inches (10.2 cm) width × 12.3 inches (33 cm) length
WEIGHT: 1.5 lb (0.7kg)

D.5 Ludlum Model 44-9 Pancake G-M Detector

INDICATED USE: Alpha beta gamma survey; Frisking
DETECTOR: Pancake type halogen quenched G-M
WINDOW: 1.7 ± 0.3 mg cm^{-2} mica
WINDOW AREA: Active – 15 cm^2; Open – 12 cm^2
EFFICIENCY (4π geometry): Typically 5 percent – ^{14}C; 22 percent – $^{90}Sr/^{90}Y$; 19 percent – ^{99}Tc; 32 percent – ^{32}P; 15 percent – ^{239}Pu
SENSITIVITY: Typically 3300 cpm $(mR\ h^{-1})^{-1}$ (^{137}Cs gamma)
ENERGY RESPONSE: Energy dependent
DEAD TIME: Typically 80 µs
COMPATIBLE INSTRUMENTS: General purpose survey meters, ratemeters, and scalers
OPERATING VOLTAGE: 900 volts
CONNECTOR: Series C (*others available*)
CONSTRUCTION: Aluminum housing with beige polyurethane enamel paint
TEMPERATURE RANGE: –4° F (–20° C) to 122° F (50° C)
SIZE: 1.8 inches (4.6 cm) height × 2.7 inches (6.9 cm) width × 10.7 inches (27.2 cm) length
WEIGHT: 1 lb (0.5kg)

D.6 Ludlum Model 44-10 Gamma Scintillator

INDICATED USE: High energy gamma detection
SCINTILLATOR: 2-inch (5.1-cm) diameter × 2-inch (5.1-cm) thick NaI(Tl) scintillator
SENSITIVITY: Typically 900 cpm $(\mu R\ h^{-1})^{-1}$ (^{137}Cs)
ENERGY RESPONSE: Energy dependent
COMPATIBLE INSTRUMENTS: General purpose survey meters, ratemeters, and scalers
TUBE: 2-inch (5.1cm) diameter magnetically shielded photomultiplier
OPERATING VOLTAGE: Typically 500 – 1200 volts
DYNODE STRING RESISTANCE: 60 megohms
CONNECTOR: Series C (others available)
CONSTRUCTION: Aluminum housing with beige polyurethane enamel paint
TEMPERATURE RANGE: –4° F (–20° C) to 122° F (50° C)
SIZE: 2.6 inches (6.6 cm) diameter × 11 inches (27.9 cm)length
WEIGHT: 2.3 pounds (1.1kg)

D.7 Ludlum Model 2221, Scaler/Ratemeter Single Channel Analyzer

INDICATED USE: Field analysis
COMPATIBLE DETECTORS: G-M, proportional, scintillation
CONNECTOR: Series “C” (others available)
AUDIO: Built in unimorph speaker with volume control (greater than 60 dB at 2 feet, full volume)
AUDIO DIVIDE: Thumb switch for 1, 10, or 100 events-per-click
AUDIO JACK: For optional headset
METER DIAL: 0 - 500 cpm; 50 - 500k cpm logarithmic scale (others available)
MULTIPLIERS: × 1, × 10, × 100, × 1k, and LOG for logarithmic scale
LINEARITY: Reading within ± 10% of true value with detector connected
DIGITAL DISPLAY: 6-digit LCD display with 0.5” (1.3 cm) digits
LCD BACKLIGHT: Activated by LAMP switch
DIGITAL RATEMETER: Provides a digital display of count rate when selector switch is in Dig. Rate position
SCALER: Used in conjunction with timer to allow for gross counting with range from 0 - 999999 counts when selector switch is in Scaler position (controlled by COUNT and HOLD buttons)
TIMER: Switch selectable divisions of 0.1, 0.5, 1, 2, 5, 10 minutes or CONT (continuous) for manual timing
CALIBRATION CONTROLS: Accessible from front of instrument (protective cover provided)
HIGH VOLTAGE: Adjustable from 200 - 2400 volts (can be checked on display)
THRESHOLD: Adjustable from 100 - 1000 (can be checked on display)
WINDOW: Adjustable from 0 - 1000 above threshold setting (can be turned on or off)
GAIN: Adjustable from 1.5 - 100 mV at threshold setting of 100
OVERLOAD: Senses detector saturation. Indicated by “------” on LCD display and meter going to full scale (adjustable depending on detector selected)
RESPONSE: Toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading
RESET: Push-button to zero meter
POWER: 4 each “D” cell batteries (housed in sealed compartment that is externally accessible)
BATTERY LIFE: Typically 250 hours with alkaline batteries (battery condition can be checked on digital display)
METER: 2.5” (6.4 cm) arc, 1 mA analog type
CONSTRUCTION: Milled and drawn aluminum with beige polyurethane enamel paint
TEMPERATURE RANGE: -4° F (-20° C) to 122° F (50° C)
May be certified for operation from -40° F (-40° C) to 150° F (65° C)
SIZE: 9” (22.9 cm) height × 4.3” (10.9 cm) width × 10” (25cm) length including handle
WEIGHT: 5.5 lbs (2.5kg) including batteries

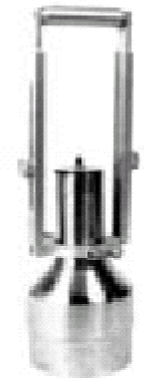
D.9 Ludlum Model 2224 Alpha/Beta Scaler/Ratemeter

INDICATED USE: Simultaneous alpha, beta counting and discrimination
COMPATIBLE DETECTORS: Proportional and dual phosphor scintillation detectors
CONNECTOR: Series C (others available)
AUDIO: Built in unimorph speaker with volume control (greater than 60 dB at 2 feet, full volume)
AUDIO DIVIDE: Selectable dual or individual click-per-event for alpha and beta counts and divisions of 1, 10, 100, or 1000 events-per-click (beta counts only)
METER: 2.5 inches (6.4 cm) arc, 1 mA analog type
METER DIAL: 0 – 500 cpm, 0 – 2 kV, BAT OK, OL(overload)
MULTIPLIERS: × 1, × 10, × 100, × 1000
LINEARITY: Reading within ± 10 percent of true value with detector connected
SCALER: 6 digit LCD display with 0.25-inch (0.64-cm) digits, overflow arrow, and colons to indicate when a count is in process
COUNT: Push-button to initiate scaler count
COUNT TIME: Internally selected times of 0.1, 0.5, 1, or 2 minutes
SELECTOR SWITCH: Toggle switch to select alpha and beta, alpha only, or beta only
HIGH VOLTAGE: Adjustable from 200 – 2000 volts (can be read on meter)
HIGH VOLTAGE ADJUST: Accessible from front of instrument (protective cover provided)
THRESHOLD: Internal control allows adjustment from 2 mV – 15 mV for beta, and 40 mV – 700 mV for alpha
WINDOW (Beta only): Internal control allows adjustment from beta threshold up to the alpha threshold setting
OVERLOAD: Senses detector saturation. Indicated by red lamp on meter and meter going to full scale (adjustable depending on detector selected)
RESPONSE: Will vary according to number of counts present. Typically 2 s – 11 s from 10 percent to 90 percent of final reading
POWER: 2 each D cell batteries (housed in sealed compartment that is externally accessible)
BATTERY LIFE: Greater than 350 hours with alkaline batteries (battery condition can be checked on meter)
CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint
TEMPERATURE RANGE: –4° F (–20° C) to 122° F (50° C)
SIZE: 6.5 inches (16.5 cm)height × 3.5 inches (8.9 cm) width × 8.5 inches (21.6 cm) length
WEIGHT: 3.5 lbs(1.6 kg) including batteries

D.10 Ludlum Model 2241 Digital Survey Meter

INDICATED USE: General purpose survey, gross counting
COMPATIBLE DETECTORS: G-M, proportional, scintillation
CONNECTOR: Series C (others available on request)
AUDIO: Built in unimorph speaker with ON/OFF switch (greater than 60 dB at 2 feet)
ALERT/ALARM: Indicated by enunciator on display and audible tone
DISPLAY: 4 digit LCD display with 0.5-inch (1.3-cm) high digits, separate enunciators for display units, alert, alarm, low battery, detector overload, counting overflow, and scaler counting
BACKLIGHT: Push-button to activate
RATEMETER: Can display in R/hr, Sv/hr, cpm, or cps when control switch is in RATEMETER position
DISPLAY RANGE: Auto ranging from 0.0 $\mu R\ h^{-1}$ – 9999 $R\ h^{-1}$; 0.000 $\mu Sv\ h^{-1}$ – 9999 $Sv\ t^{-1}$; 0 cpm – 999k cpm; or 0 cps – 100 kcps
LINEARITY: Reading within ± 10 percent of true value with detector connected
SCALER: Activated by push-button in handle (count time adjustable from 1 to 9999 s in 1-s intervals)
CALIBRATION CONTROLS: Accessible from front of instrument (protective cover provided)
HIGH VOLTAGE: Adjustable from 200 volts – 2500 volts
DISCRIMINATOR: Adjustable from 2 mV – 100 mV
OVERLOAD: Indicated by OVERLOAD on display (adjustable depending on detector selected)
RESET: Push-button to zero display, acknowledge and/or reset alarm
POWER: 2 each D cell batteries (housed in sealed compartment that is externally accessible)
BATTERY LIFE: Typically 200 h with alkaline batteries (low battery indicated on display)
CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint
TEMPERATURE RANGE: –4° F (–20° C) to 122° F (50° C)
SIZE: 6.5 inches (16.5 cm) height × 3.5 inches (8.9cm) width × 8.5 inches (21.6cm) length
WEIGHT: 3.5 lbs (1.6 kg) including batteries

D.11Thermo Electron Corporation G5 "FIDLER" NaI(Tl) Scintillation Probe



Radiation Detected: Gammas and X-rays >10 keV
Pulse Height Resolution: < 30 percent FWHM for ^{109}Cd (23 keV)
Scintillation Crystal: Nal(Tl), 5 inches diameter × 0.010 inch thick (127 mm × 50.8 mm)
Radiation Entrance Window: Beryllium, 5 inches diameter × 0.10 inch thick (127 mm × 0.254 mm)
Optional Window Materials: Low background Be for maximum low-energy sensitivity; reduces background count range by about 24 percent; Aluminum, reduces efficiency by about 20 percent
Housing: Aluminum, 0.020-inch (0.50 mm) thick, satin chrome finish
Photomultiplier Tube: 5 inches (127 mm) diameter
Light Shield: Mu metal, satin chrome finish
Operating Voltage: Variable
Maximum Voltage: +1600 volts
Voltage Divider: Internal, integrally-wired; 14-pin base optional
Termination: Single MHV connector; other terminations available
Temperature range: +39º F to +109º F (+ 4 C to + 43º C)
Temperature Rate-of-Change: 18º F (10º C) per hour
Size: Standard = 5.562 inches maximum diameter × 10.125 inches long (141.3 mm × 257.2 mm)
Ruggedized = 6.250 inches maximum diameter × 10.583 inches long (158.7 mm × 268.8 mm)
Weight: Standard = 6 lb (4.1 kg)

D.8 Ludlum Model 12-4 Neutron Counter

PART NUMBER:48-1200

- ***4 Ranges***
- ***Splashproof Shields***
- ***Dose Response***
- ***Total Range from 0 - 10,000 mrem/hr***

INDICATED USE: Neutron Survey
WORKING ENVIRONMENT: Splash proof shields for outdoor use
DETECTORS: 1.6 cm diameter X 2.5 cm thick BF^3 detector surrounded by a 9"(22.9 cm) diameter cadmium loaded polyethylene sphere
SENSITIVITY: Approximately 30 cpm/mrem/hr (*AmBe neutrons*)
NOTE: This unit provides an approximate inverse RPG curve for neutrons from thermal through 10 MeV
GAMMA REJECTION: Less than 10 cpm through 10 R/hr
AUDIO: Built in unimorph speaker with ON/OFF switch (*greater than 60 dB at 2 feet*)
METER DIAL: 0 - 10 mrem/hr, 0 - 2.5 kV, BAT TEST (*others available*)
MULTIPLIERS: X1, X10, X100, X1000
LINEARITY: Reading within plus or minus 10% of actual value
CALIBRATION CONTROLS: Accessible from front of instrument (*protective cover provided*)
HIGH VOLTAGE: Adjustable from 200 - 2500 volts (*can be read on meter*)
DISCRIMINATOR: Adjustable from 2 - 60 mV
RESPONSE: Toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading
RESET: Push-button to zero meter
POWER: 2 each "D" cell batteries (*housed in sealed compartment that is externally accessible*)
BATTERY LIFE: Typically 600 hours with alkaline batteries (*battery condition can be checked on meter*)
METER: 2.5"(6.4cm) arc, 1 mA analog type
CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint
TEMPERATURE RANGE: -4° F(-20° C) to 122° F(50° C)
May be certified for operation from -40° F(-40° C) to 150° F(65° C)
SIZE: 17"(43.2cm)H X 9"(22.9cm)W X 10.5"(26.7cm)L
WEIGHT: 21 lbs(9.5 kg) including batteries

D.12 ThermoEberline Hand$_E$Count Alpha/Beta Counting System

Detector: 2-inch diameter, alpha and beta sensitive phosphor scintillator
Efficiency: Alpha ^{239}Pu: > 90 percent (2π); Beta ^{99}Tc: > 35 percent (2π), ^{90}Sr/^{90}Y > 40 percent (2π)
Background: < 60 cpm in the beta channel and < 1 cpm in the alpha channel in background of 25 μR h- ^{137}Cs gamma.
Crosstalk: Alpha to beta and beta to alpha cross over correction are automatically corrected per parameters established in the calibration process
Sample Drawer: 2.03-inch diameter × 0.38-inch thick (5.16-cm × 0.95-cm) maximum. The sample thickness can be adjusted between 1/8 to 5/16 inches. The sample holder and slide are black anodized for ease of decontamination.
Mechanical: Single package design to allow for easy portability facilitated by a carrying handle.
Display/Controls: Palm™ handheld computer, Model IIIc.
Units: Counts, cpm, cps, Bq, DPM, DPS, each unit may also include a suffix for the area desired
Count Time: User selectable count time between 1 s and 60 minutes
Background Update: User selectable count time 1 s to 60 minutes utilized in background subtraction of sample counts
Alarms: User-defined alarm limits on samples, Out of Calibration, Calibration: On board program facilitates a menu driven calibration routine to optimize HV, alpha/beta thresholds and crosstalk values. Efficiencies are automatically computed based upon user-defined sources. Program includes a user-defined database of sources for quick selection. Automatic decay correction of sources is automatically calculated. All calibration data are protected in non-volatile memory. The next calibration date is automatically computed based upon the user-defined frequency. The HandECount program provides advance warning of upcoming calibration dates.
Power Supply: 110 VAC, 60 Hz standard, optional 220 VAC, 50 Hz
Check Source: Software routine permitting quick verification and operability of the instrument to user-defined acceptance criteria.
Passwords: Protect setup and calibration information via two levels of password controls.
Count Storage: Data log samples using sequential numbering or user input identification via the Palm™ Graffiti interface for approximately 5000 samples. Each data point will include sample ID, sample count type, sample count result, counter serial number, time, date, instrument status etc.
Temperature: 0 to 50 degrees C (32 to 122 degrees F)
Humidity: 10 to 90 percent non-condensing
DT Correction: Dead time correction from 0 to 250 μs.
Count Range: 1 to 1.2 million cpm
Audible: The Palm™ audible output is used to signal Countdown timer, when the sample has completed its count, and whenever an alarm occurs (when activated).
Options: Windows™ based PC conduit program to retrieve all logged data and calibration information.
Battery pack supporting up to 8 hours operation
Testing: CE-Certified, ANSI N42.17
Size: 15 inches High × 4.75 inches Wide × 12 inches Deep
Weight: 11 lbs. (13 lbs with battery option)

Appendix E

Minimum Detectable Concentrations

Minimum Detectable Concentrations

Results in the characterization survey report (pending) will be the definitive information guiding remediation efforts and radioactive waste disposal. The information in this appendix is for Earth Tech's field use and for approximate confirmation of characterization survey results.

Determination of all of the following MDCs is dependent on background radiation, which Earth Tech has not yet measured. When actual background radiation count rates have been measured, these calculations will be updated and included in the project report.

E.1 Volumetric MDCs

E.1.1 ^{241}Am

The FIDLER has the capability to detect ^{241}Am at levels as low as 0.2 μCi m^{-2}.[*] Assuming a soil density of 1.6 g m^{-3} and a contamination depth of 15 cm, this implies a MDC for ^{241}Am of about 1 pCi g^{-1}, which is less than the 25 TAC 289 limit of 6 pCi g^{-1} for ^{241}Am.

Earth Tech will calibrate the FIDLER used for field measurements onsite and determine the actual MDC based on local conditions.

The three radioisotopes of concern may occur together. The characterization survey is expected to indicate when this occurs. Levels of ^{137}Cs and ^{226}Ra above normal background concentrations will increase the background counts in the energy channels the FIDLER uses to detect ^{241}Am. Earth Tech will consider this as necessary in the calibration of the FIDLER for measuring ^{241}Am contamination.

E.1.2 ^{137}Cs

MARSSIM Table 6.7 indicates that a typical scanning MDC for ^{137}Cs using a 2-inch × 2-inch NaI(Tl) detector is about 6.4 pCi g^{-1}. This MDC is below the 25 TAC 289 limit of 40 pCi g^{-1} for ^{137}Cs.

The calculations (*MARSSIM* paragraph 6.7.2) assumed a cylindrical area of elevated activity is 0.25 m^2 (radius of 28 cm), the depth of the area of elevated activity is 15 cm, the dose point is 10 cm above the surface, and the density of soil is 1.6 g cm^{-3}.

E.1.3 ^{226}Ra

MARSSIM Table 6.7 indicates that a typical MDC for ^{226}Ra using a 2-inch × 2-inch NaI(Tl) detector is about 2.8 pCi g^{-1}. This MDC is below the 25 TAC 289 limit of 5 pCi g^{-1} for ^{226}Ra in the top 15 cm of soil.

The calculations (*MARSSIM* paragraph 6.7.2) assumed a cylindrical area of elevated activity is 0.25 m^2 (radius of 28 cm), the depth of the area of elevated activity is 15 cm, the dose point is 10 cm above the surface, and the density of soil is 1.6 g cm^{-3}.

E.2 Surface MDCs

E.2.1 Static MDCs

According to *MARSSIM*, the critical level (L_C) is the level, in counts, at which there is a 5 percent statistical probability of incorrectly identifying a measurement system background value as greater than

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[*] Paragraph 5-A.1-6, X-Ray Detection, DoD 5100.52-M, *Nuclear Weapon Accident Response Procedures (NARP) Manual*, September 1990.

background. Any response above this level is considered greater than background. The detection limit (L_D) is an *a priori* estimate of the detection capability of a measurement system and is reported in units of counts. The MDC is the detection limit (counts) multiplied by an appropriate conversion factor to give units consistent with a site guideline, such as picocuries per gram (pCi $g^{-1)}$ or dpm per 100 cm^2. In other words, the MDC is the *a priori* net activity level above the critical level that an instrument can be expected to detect 95 percent of the time.

MARSSIM explains how to calculate L_C, L_D, and MDC and arrives at the following result (*MARSSIM* equation 6-7) for the static MDC:

$$\text{Static MDC} = C\left(3 + 4.65\sqrt{B}\right)$$

where C represents total detection efficiency and other constants or factors needed to put the static MDC into appropriate units and B is the number of background counts that are expected to occur while performing an actual measurement. All static counts were taken in one minute.

For the present purposes:

$$C = \frac{1}{A\varepsilon_i\varepsilon_s} \times \frac{100\ \text{cm}^2}{100\ \text{cm}^2}$$

where A is the effective area of the probe, ε_i is the instrument or detector efficiency, $\varepsilon_s = 0.5$ is the efficiency of the contamination source, and the final factor, which equals 1, helps put the units of scan MDC into dpm/100 cm^2.

Table E–1 lists the static MDCs for instruments Earth Tech, Inc., used for clearance measurements. Efficiencies were taken from manufacturer's literature. Static background measurements are estimated and will be updated during the survey. Static MDCs were rounded to one or two significant digits so that implied accuracy is not overstated.

Table E-1. Instrument Efficiencies and Static MDCs.

Detector	Effective Probe Area (cm^2)	Instrument Efficiency (cpm/dpm)	Backgro und (cpm)	Static MDC (dpm/100 cm^2)
Ludlum model 43-89 alpha/beta scintillator	100	0.12 (α) 0.15 (β)	3 (α) 268 (β)	200 (α) 1100 (β)
Ludlum model 44-9 pancake GM detector	12	0.18 (β)	60 (β)	3600 (β)

E.2.2 Scan MDCs

The minimum detectable concentration of a scan survey (scan MDC) depends on the intrinsic characteristics of the detector (such as efficiency and physical probe area), the nature (type and energy) of emissions, the relative distribution of the potential contamination (point versus distributed source and depth of contamination), scan rate, and other characteristics of the surveyor. *MARSSIM* section 6.7.2.1 discusses the basis for estimating scanning MDCs and arrives at the following equation for scan MDC:

$$\text{Scan MDC} = \frac{\text{MDCR}}{\sqrt{p}\, A\, \varepsilon_i\, \varepsilon_s} \times \frac{100\ \text{cm}^2}{100\ \text{cm}^2}$$

where MDCR is the minimum detectable count rate (interpolated from *MARSSIM* table 6.6), p is surveyor efficiency (assumed to be 0.5), and other parameters are shown above. The final factor, which equals 1, helps put the units of scan MDC into dpm/100 cm^2.

Table E-2 lists scan MDCs for instruments Earth Tech, Inc., used for clearance measurements. Scan MDCs were rounded up to one or two significant digits so that implied accuracy is not overstated.

Table E-2. Scan MDCs.

Detector	MDCR (cpm)	Scan MDC (dpm/100 cm^2)
Ludlum Model 43-89 Alpha/Beta Scintillator	92	2000
Ludlum Model 44-9 Pancake GM Detector	55	6000